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HARTFORD BUILDING, UNION SQUARE
22 EAST SEVENTEENTH STREET, NEW YORK

Entered as second-class matter, August 8, 1916, at the Post Office at New York, N. Y., under act of March 3, 1879

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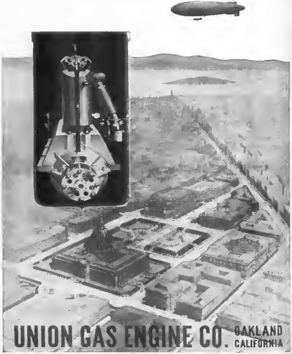
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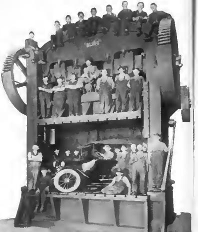

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MAY 1, 1919

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VI. NO. 7

Member of the Audit Bureau of Circulations

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THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*

HARTFORD BUILDING, UNION SQUARE, 22 EAST SEVENTEENTH STREET, NEW YORK

WASHINGTON OFFICE, EVENING STAR BUILDING

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol. VI — May 1, 1919 — No. 7

THE imminence of the start of NC Seaplane Division 1 under the leadership of Comdr. John H. Towers, U. S. N., in its attempt to cross the Atlantic under its own power, is focusing public attention on this great venture chiefly by virtue of its appeal to imagination and the human element involved.

This is quite natural and justified, for in man's struggle against the hostile forces of Nature it is the human element behind the machine, rather than the mere perfection of mechanism, which in the last analysis accounts for the outcome. Nowhere is this more true than in aerial navigation, where the devotion and professional skill play a preponderant role in making for success or failure.

However, while the greatest credit will justly be due to the men who first succeed in flying an aircraft across the Atlantic, a very great share of appreciation should go to the engineers responsible for the design of the victorious machine.

In the case of our NC boats credit for having developed this type of seaplane belongs to Rear Admiral David W. Taylor and Comdrs. G. C. Westervelt, H. C. Richardson and J. C. Hunsaker, Construction Corps, U. S. N., whose important and successful work in aeronautical engineering particularly fitted them for the arduous task of designing the American competitors for the blue ribbon of the Atlantic—which are incidentally the most powerful aerial scouts of the United States Navy.

It should be noted that the NC boats, originally destined to act as long range patrol and convoy craft, and mounting powerful armament for the destruction of hostile submarines, were designed last summer with the express purpose of crossing the Atlantic under their own power. This was made necessary by the lack of shipping then available as well as by the great amount of space these huge flying boats would have taken up when crated. It was therefore decided to have the NC boats make the ocean flight without any armament and only carrying the crew strictly necessary for this purpose, and have them re-fitted for their special functions in Europe. The termination of hostilities has eliminated the military reasons for this flight only to a certain extent; indeed quite aside from the sporting element involved, the trans-Atlantic flight assumes for the United States Navy the significance of an efficiency performance which is to show the value of the engineering talent employed in constantly perfecting our first line of defense.

With the help of a tolerable amount of luck the NC Seaplane Division 1 should succeed in winning the first place in the trans-Atlantic flight contest, and if so, the greatest praise should be bestowed upon the capable officers of the Construction Corps, U. S. N., who possessed vision enough to undertake during the war the design of a seaplane which would reach the scene of hostilities under its own power.

Design of Rubber Shock Absorbers

A study of recent designs would seem to indicate that the shock absorbing properties of the rubber shock absorber on the average airplane are not in keeping with the strength of the machine.

Thus for a machine weighing about 4900 lb. the maximum axle deflection was 5 in. and the total load which could be carried by the rubber cords was only 10,000 lb., a factor of safety of not more than 2, while the chassis itself, as regards struts and axle, certainly had a strength of 5 to 6 over the gross weight of the plane.

It would seem advisable to remove such discrepancies in design, so as to build machines which follow through in the chassis just as elsewhere.

The difficulty is that in order to obtain the necessary load in the rubber cords with the usual type of cord an excessive quantity of rubber has to be employed, which gives a clumsy looking chassis.

This would mean that on a hard landing the resiliency of the rubber would be used up at once, and a great shock transmitted to the chassis with bad results.

It would certainly seem advisable to remove such a lack of follow-through in chassis design.

This might be done in three ways. By increasing the number of turns of cord; by decreasing the original length of the cord when applied to the machine; or finally by increasing the initial tension in the rubber when the elastic is woven.

The first method implies a very large increase in the number of cords employed, with a correspondingly clumsy looking chassis. The disadvantage of the second method is that it involves difficulty in applying the cord when the machine is to be set up. A workman would have to exercise great strength to apply the cord at all. The third method implies the use of a cord having somewhat different characteristics from those commonly on the market. The rubber is compressed when the elastic is woven, and consequently is in a state of strain and tension initially, so that a greater proportion of the total strength is developed at the time when the axle has reached its maximum deflection.

British cords have achieved this object very satisfactorily, and one or two American manufacturers have also attained the same end. If airplane designers insist on a cord having these characteristics an improvement in chassis strength will follow without extra expense or the exercise of much ingenuity, as it is a comparatively simple matter to weave the cord so as to get the initial tension.

Trans-Atlantic Flight and Meteorology*

By Willis Ray Gregg

The purpose of this paper is briefly to present (1) a statement giving the present state of our knowledge relative to average surface meteorological conditions over the North Atlantic, (2) a similar statement as to free-air conditions, and (3) an analysis showing the assistance that may be rendered by the winds, providing an aviator, with this in mind, carefully selects his time for flight.

Before taking up these points in detail a few words should be said as to possible routes. Those most frequently proposed for the trip from America to Europe and return are (a) Newfoundland to Ireland and (b) Newfoundland to the Azores, thence to Portugal. Another suggested route is from Labrador to Scotland, via Greenland and Iceland. The only advantage of this route over others is the shorter distance between successive landing points. Among its disadvantages are lower temperatures than over the routes farther south, difficulty of providing suitable landing places in Greenland and Iceland and of finding them even if they could be established, greater probability of cloudiness and of opposing winds, since this route lies to the north of the region of greatest storm frequency, difficulty, if not impossibility, of securing meteorological data at the time of flight, and remoteness from steamship routes and, therefore, improbability of rescue in case of accident. Inasmuch as airplanes of sufficient power and capacity have been developed for flying a distance at least as great as that from Newfoundland to the Azores the extreme northern route will be given no further consideration.

For the return trip from Europe to America there have been proposed, in addition to the two already mentioned, a route from Portugal to northern Brazil, Guiana, or Venezuela, and one from Portugal to the Lesser Antilles. In these instances, however, the flights contemplated were to be made by means of relatively slow-traveling airships (dirigibles). For the eastward journey there were to go direct from Newfoundland to Ireland, thus adding to the inherent speed of the airship the assistance furnished by the prevailing westerlies. In returning, however, the wind resistance offered would be so great as to make the journey hazardous and on a large percentage of days impossible. The southern routes would not only avoid these head winds, but would be for the most part in the region of the northeast trades. In spite of their greater distances, therefore, those southern routes offered decided advantages for airships. In the case of high-speed airplanes, on the other hand, the assistance furnished by the trade winds would be offset in large part, if not altogether, by the greater distance to be traveled. The properly selected days the less favorable winds along the routes farther north would be more than compensated for by the shorter distances.

1. Average Surface Weather Conditions

Temperatures.—Temperatures are of interest chiefly in connection with their effect upon the aviators and upon engine performance. In Table I are given average monthly and annual values at four selected places.

Annual and diurnal ranges, as well as those due to abrupt changes in weather, are greatest in Newfoundland and least in the Azores. Minimum temperatures as low as —25 deg. C have been observed at St. Johns and as low as —5 deg. C. at Valentia. Freezing temperatures have never been reported in the Azores or at Lisbon.

Relative humidity.—Comparatively little has been done in a critical way in the study of humidity conditions over the oceans. Among the most interesting observations are those on the British steamship *Scotia* and on the U. S. Coast Guard cutter *Seneca*. These observations were made in the late spring and early summer months and showed in practically all cases a relative humidity above 80 per cent. A large number of observations in December, as computed by the marine section of the Weather Bureau, gave an average value of 86 per cent.

Cloudiness.—The average cloudiness along the northern route is about 70 per cent throughout the year. This statement is somewhat misleading, so far as aviation is concerned, inasmuch as fogs are included with clouds in arriving at this result and, as will be shown later, these fogs extend to low altitudes only and the aviator would, therefore, oftentimes have a clear sky above him, whereas at the earth's surface 100 per cent cloudiness would be recorded. It is probable that in summer the average cloudiness above the fog level is about 50 to 60 per cent. Between Newfoundland and the Azores it varies from 65 per cent in winter to 55 per cent in summer, and between the Azores and Portugal, from 55 to 45 per cent.

TABLE I.—MEAN MONTHLY AND ANNUAL TEMPERATURES DEG CENT

	St Johns	Valentia	Azores	Lisbon
January	7	7	14	10
February	— 5	7	14	11
March	— 2	7	14	12
April		8	16	14
May	6	11	17	16
June	11	14	18	19
July	17	15	21	21
August	16	15	22	[illegible]
September	12	14	21	20
October	7	11	18	16
November	1	8	17	13
December	— 2	7	15	10
Annual	[illegible]	10	18	[illegible]

Precipitation.—Precipitation (rain) normally occurs on about 160 days in Newfoundland, 200 in Ireland, 170 at the Azores, and 100 in Portugal. Over the ocean it probably occurs on about 200 to 250 days along the northern route and on about 150 to 200 days along the southern route.

Fog.—One of the most serious obstacles to trans-Atlantic flight appears to be the large percentage of days on which fog occurs, particularly near the American coast. This amounts in the regions southeast and east of Newfoundland to about 60 per cent in summer and about 20 to 35 per cent in winter, the frequency in the latter season being greatest to the southeast. Near the Irish coast it varies from about 10 per cent in summer to 5 per cent in winter. Fogs rarely occur near the Azores or between them and Portugal. In general the Newfoundland fogs occur as the result of warm moisture-laden winds blowing from the Gulf Stream regions over the cold waters of the Labrador Current. Another kind of fog encountered in this part of the Atlantic is a calm-weather fog of small vertical extent in which the sea is slightly warmer than the air. These fogs occur only during calm weather and quickly disperse as soon as a breeze sets in.

Pressure.—Pressure distribution over the North Atlantic may be briefly described as consisting essentially of a belt of high pressure, known as the "Horse Latitudes" at about latitudes 30 deg. to 35 deg. N., with a semipermanent *high* near the Azores, and a belt of low pressure at about latitude 60 deg. N. with lowest values in the vicinity of Iceland.

Wind.—As a result of the pressure distribution, thus briefly outlined, winds in summer are from a west-southwesterly direction, with a mean velocity of 8 m.p.s.; at all points along the northern route; in winter they are westerly, with a slight north component, i. e., a component from the north, mean velocity about 10 m.p.s., from Newfoundland to longitude 45 deg. W. Farther east they have a strong south component, becoming southwesterly near the British Isles. The mean velocity along this section of the course is 10 to 15 m.p.s., being highest between longitudes 45 deg. and 20 deg. W. Over the southern course winds in summer are southwesterly, 8 m.p.s., to longitude 40 deg. W., variable and light thence to the Azores, and northerly, 8 m.p.s., between the Azores and Portugal. In winter they are west-northwesterly, 10 m.p.s., to longitude 40 deg. W., westerly, 10 to 12 m.p.s., thence to the Azores, and west-southwesterly, 10 m.p.s., between the Azores and Portugal. The percentage of winds from a westerly direction, i. e., between north-northwest and south-southwest, varies along the northern route from about 85 in winter to 70 in summer, near the Azores, from 75 to 65, and from the Azores to Portugal, 40 to 30. In the last named region winds from all directions are about equally frequent in winter, but in summer northerly winds predominate.

Gales.—Practically all of the cyclonic disturbances that move across the United States, no matter what their place of origin, enter the North Atlantic Ocean slightly to the south of Newfoundland, moving thence east-northeastward

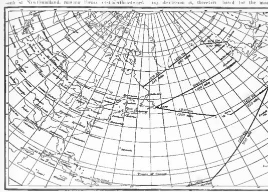

Fig. 1. Proposed Routes for Trans-Atlantic Flight

toward the Iceland *low*, and thus crossing the northern route roughly between longitudes 30 deg. and 40 deg. W. These storms vary considerably in size, intensity, and rate of travel. In general, they are larger and travel more slowly over the ocean than over the continents. They are, moreover, more frequent, more intense and faster moving in winter than in summer. In their movements across the Atlantic, the more intense cyclones are often accompanied by gales having a velocity of more than 20 m.p.s., the directions of these gales depending upon the part of the storm in which the observations are made. Along the Ireland route the percentage of days on which such gales occur varies in general from about 25 in winter to 5 in summer. In winter they are often accompanied by violent snow squalls. From Newfoundland to the Azores the percentage frequency of gales is about 20 in winter and 3 in summer, from the Azores to Portugal, about 7 and 1, respectively.

Tropical cyclones.—Tropical cyclones, or hurricanes, occur only in the summer and autumn months, reaching their greatest frequency in August, September, and October. The average number in each year is only about 3 to 5. These storms generally originate in the region between the West Indies and the northern coast of South America, whence they travel slowly northwestward, then northward, to the southeastern coast of the United States. From this region they usually move northeastward along the coast and assume the characteristics of extratropical cyclones. So far as trans-Atlantic flight along the two courses under consideration is concerned, the aviator need therefore feel no more anxiety from hurricanes than from the areas of low pressure that originate in different portions of this country and enter the Atlantic Ocean from the St. Lawrence Valley.

2. Average Free-Air Conditions

On this subject there is but little information available, so far as actual observations are concerned. The following discussion is, therefore, based for the most part on numerous free-air observations that have been made over the eastern portions of the United States and Canada and in different parts of Europe, and an effort is made to apply these results to the air over the ocean, bearing in mind the relative effects of land and water surfaces on the distribution of the meteorological elements above them.

Temperature.—In general, it may be said that the lower the surface temperatures, as compared with the seasonal normal, the smaller is the rate of decrease with altitude. In other words, during cold waves with clear skies and especially during the early morning hours, inversions almost invariably occur. During cloudy weather, i. e., low clouds, temperatures generally decrease from the surface to the cloud layer and increase slightly for a short distance above it.

In the application of the foregoing statements to the free air above the ocean it is important to recognize certain fundamental differences between land and water surfaces in their absorption and radiation of temperature. Water surfaces reflect about 40 per cent of the insolation that reaches them and absorb the remaining 60 per cent. Much of the heat thus absorbed is, however, used in evaporating the water and some of the remaining is distributed both vertical-

* Excerpt from a paper presented before the Philosophical Society of Washington, March 29, 1919.

ly and horizontally by the constant movement of the water and by the penetration of the light rays to lower levels, the result being that the surface and therefore the air in contact with it maintains a relatively constant temperature. Land areas, on the other hand, reflect and transmit very little insolation and there is but little evaporation. The specific heat of land is less and moreover there is no movement, as in the case of water, whereby the heat received can be conveyed vertically or horizontally. Hence land areas become strongly heated during insolation and similarly cooled in its absence.

The diurnal variation of temperature at the surface in any one locality at sea is seldom greater than 1 deg. Cent. In general it is probable that the change is not much larger in the free air above the ocean, except that, in the case of coastal waters, winds blowing offshore would bring their characteristic diurnal variations of temperature with them.

TABLE II.—PROBABLE TEMPERATURE CONDITIONS, DEG. CENT. AT 1 KILOMETER ABOVE SEA IN DIFFERENT PORTIONS OF THE NORTH ATLANTIC

	Near Newfoundland		Near Ireland		Between Azores and Portugal	
	Summer	Winter	Summer	Winter	Summer	Winter
Mean	10	[illegible]	10	[illegible]	[illegible]	10
Highest	25	10	[illegible]	10	[illegible]	20
Lowest	[illegible]	10			10	

It must be distinctly understood that these figures are merely estimates, they are the nearest to actual conditions that we can get at the present time. Considered with reference to those in Table I they indicate that at an altitude of 1 kilometer temperature changes along both routes would be less than at the surface, that rarely would temperatures be much below freezing along any part of either route, and that in summer a trip would be attended by mild and comfortable temperatures throughout. The fogs off the coast of Newfoundland should cause no concern in this respect; for, as will shortly be shown, they are low lying, and above them temperatures are higher than at the surface.

Humidity.—Over land areas relative humidity generally decreases with altitude during clear weather or when only high clouds of the cirrus type are present. As a rule, it falls to about 50 per cent at an altitude of 1 kilometer, but occasionally as low as 20 per cent. When there are low clouds, the humidity remains high to the upper limits of the cloud layer and decreases rapidly above it. When all conditions of weather are considered, the average decrease with height is not large, amounting to only about 10 per cent from the surface to 1 kilometer above it. It is greatest in winter and least in summer. At altitudes greater than 1 kilometer the relative humidity remains practically constant. Above the ocean, due to the higher humidities at the surface, this decrease is probably larger, amounting on the average to 20 or 30 per cent. The storm observations showed in some cases exceedingly low values at altitudes of less than a kilometer, even with dense fog at the surface. In general, it is probable that an aviator flying at an altitude of about 1 kilometer would experience along the northern route humidities of 50 to 60 per cent in clear weather or when high clouds are present and about 80 to 100 per cent in weather with low-lying clouds. Along the southern route somewhat lower humidities than 50 per cent would prevail during clear weather, but with overcast skies they would be about the same as along the northern route.

Height of fog.—There is every reason to believe that in the great majority of cases fogs extend to a low altitude only above the sea. This is clearly shown in the kite records obtained on the *Scotia* and on the *Seneca*. The top of the fog is very definite, and above it the relative humidity decreases rapidly. The temperature usually increases from the surface to the top of the fog and decreases above it. Of the nine kite records in fog obtained on the *Scotia* only one showed fog extending to a height greater than 300 meters, the average being about 150 meters. The one exception was due to long-continued blowing of warm air over successively colder areas, but, even in this case, the top of the fog was at a height of less than 600 meters. Ten kite flights in fog were made from the deck of the *Seneca*, and the temperature gradients indicate that in only one did the fog extend to a height greater than 250 meters. In the one exception it is impossible to give the exact height of the fog, as no humidity values were obtained, but the temperature record indicated an altitude of about 950 meters.

Winds.—Observations with kites and balloons in this country and in Europe have brought out the following facts with respect to average free-air wind conditions. Velocities are slightly greater at all altitudes in America than in Europe, but aside from this difference the same general tendencies are shown in both countries, viz., a rapid increase, amounting to very nearly 100 per cent, from the surface to about 500 meters above it; practically constant velocity in summer and a small increase in winter from the 500 to the 1000 meter levels above the surface; and a steady increase in both seasons, but greater in winter than in summer, from the 1000 meter level above the surface to greater altitudes. The mean seasonal difference is about 1 m.p.s. at the surface and 2 to 4 m.p.s. at an altitude of 1 kilometer. Moreover, all observations show that the increase in wind velocity from the surface to 500 meters above it is practically the same for all directions of wind, but that at higher levels winds from an easterly direction rapidly diminish in strength, whereas those from a westerly direction rapidly increase. The easterly winds usually die out altogether at about an altitude of 2000 meters, and at higher levels westerly winds prevail. The shifting from one type to the other is usually always clockwise with surface winds from east to south and as a rule counterclockwise with surface northeast to north winds. The amount of the turning is directly related to the angle of deviation of the surface wind direction from that of the prevailing westerlies.

Winds, as is well known, tend to flow at right angles to the direction in which the pressure gradient acts, i.e., parallel to the isobars. Owing, however, to friction and eddies, the direction of motion of the surface wind is nearly always inclined to the isobars. The amount of this inclination is greatest in anticyclones and least in cyclonic systems, the average value on land surfaces being about 40 deg. Inasmuch as these disturbing influences largely disappear in the free air, we should expect the winds invariably to veer with altitude.* That there are exceptions to this is due to the unequal vertical distribution of temperature that often obtains in adjacent localities, thus producing in the free air isobaric systems decidedly different from those at the surface. Nevertheless, in general it is found that the winds at an altitude of 1 kilometer follow quite closely the direction of the surface isobars. This means that on the average they veer about 40 deg. from those near the ground. The case is somewhat different over the ocean. Here there is less friction, less turbulence, and there are no topographic interferences at all comparable with those on land. Hence we should expect to find the winds even at the surface blowing more nearly parallel to the isobars, and an inspection of marine synoptic weather maps indicates that this is true, the average inclination being about 10 deg. It means that the veering of winds with altitude is about 25 deg. less over the ocean than over land surfaces. In a similar manner velocities are affected, with the result that they are higher over the sea than on land, that is, they more nearly approach true gradient velocities. It has already been stated that observations show above land an increase of about 100 per cent in velocity within the first 500 to 1000 meters of the surface. Over the sea [illegible] nearly twice as strong as those on land. Hence the increase with altitude over the sea is much less than over the land. In other words a trans-Atlantic aviator would not need to fly so high as would a trans-continental aviator in order to derive the greatest assistance from the winds, and, conversely, in the case of opposing winds there would be less advantage in flying at a low altitude over the ocean than over the land. Whatever the wind direction, whether favorable or unfavorable, flying at low levels above the sea would be less dangerous than at similar levels above the land because the air there is less turbulent or "bumpy."

(*To be concluded*)

* This veering with altitude is at times visible in the way in which the smoke from altitude ascends. [illegible] J. W. Whipple [illegible] 1918 [illegible]

Airplane Propeller Wastage Reduced

By Rolf Thelen

Throughout the war the development of the best practice in propeller manufacture, which is a highly specialized art requiring a thorough knowledge of wood technology as well as the greatest degree of skill in woodworking and gluing, has been the goal of constant co-operative effort by the Forest Products Laboratory of the Forest Service and the War and Navy Departments. As a result of this joint work, methods have been perfected which insure the production of the highest type of propeller with the minimum wastage due to rejection on account of poor manufacture or improper handling before, during, or after manufacture. These methods have been adopted in the manufacture of American training and combat propellers and have contributed their share to the well known excellence of these propellers. In this connection it is interesting to note that, in the case of the Allies, it is reported that 80 per cent of the propellers received at the front were rejected on account of improper methods in handling and manufacture.

The regular researches of the Forest Products Laboratory on wood technology have been under way for many years. Its activities in connection with propeller investigations, which are in addition to these, may be grouped under four general heads, as follows: (1) Drying and storing of propeller stock. (2) Selection of laminations with proper regard for direction of grain, and density and moisture condition. (3) Glues and gluing. (4) Protection and storage of finished propellers.

Propeller lumber, as it comes from the sawmill, is usually 1 in. thick, 6 in. or more wide, and 8 ft. or more long. This lumber is green when cut and must be seasoned before it can be used in propeller manufacture.

While it is quite possible to air-season propeller lumber satisfactorily, the time required is excessive when war is in progress and speed is essential. Hence it became necessary to develop a method of artificial seasoning which would not injure the properties of the wood. The Forest Products Laboratory, which already possessed a great deal of experience in kiln drying wood, attacked the specific problem of the proper artificial drying of propeller woods, and developed a method whereby the stock could be perfectly dried in a week or two. This method was adopted as standard by both Army and Navy and used for all propeller stock with the exception of certain relatively small amounts which had been cut before the declaration of war and which were available in the air seasoned condition. The Laboratory had already developed a dry kiln in which this method of drying could be carried out, and a number of batteries of kilns of this type were built for drying aircraft lumber. Among these is the battery at Vancouver, Wash., one of the largest batteries of dry kilns in the world. This battery was erected especially for drying spruce and Douglas fir airplane stock.

In developing this process, many experimental drying runs were made upon the various woods used for propellers, and the properties of the kiln-dried material were compared with those of similar material carefully air-dried. This comparison was reached through the medium of many thousand strength tests made both upon the kiln-dried material and upon that which had been air-dried. As a check, strength tests were also made upon green material. The conclusion drawn from this work is that properly kiln-dried material is appreciably better than the best air-dried stock. This had been forecast by the Laboratory's engineers, who based their judgment upon the fundamental principles involved.

After the stock has been dried, it must be stored under proper conditions of atmospheric temperature and humidity, in order that final adjustment of the moisture in the wood may take place and that it may contain just the right degree of moisture when it is finally made up into propellers. This degree of moisture depends upon the atmospheric conditions of the locality where the propellers are to be used. Thus, training propellers for the southern fields required drier wood than was needed for battle propellers to be used on the battle lines in France. The Laboratory conducted researches to determine the relation between atmospheric conditions and the amount of moisture contained in the wood when exposed to these conditions, and it furnished the data upon which are based the specifications for atmospheric temperature and humidity in propeller factories and store rooms.

Propellers are almost sure to swell and shrink during storage and use unless they are manufactured with the greatest possible care and specially treated to prevent changes in moisture when changes in atmospheric conditions take place. The problem of reducing this swelling and shrinking to a minimum and of leaving the remainder as uniform as possible received the most serious attention of the Laboratory. It was determined that the amount and character of swelling and shrinking was, in general, due to three factors, namely, grain, density, and moisture. The shrinkage and swelling of wood with changing moisture content is not uniform in all directions. The shrinkage lengthwise is practically negligible, while that measured in a direction corresponding to the circumference of the tree is about 1½ times that measured in a direction corresponding to the diameter of the tree. Shrinkage depends also upon the weight or density of the specimen, dense pieces having a greater shrinkage than light ones.

Shrinkage or swelling, when the wood changes from one moisture condition to another, varies with the amount of the change—the greater the change in moisture, the greater the change in the volume of the piece. Bearing these three points in mind, it is evident that to obviate troubles from shrinkage and swelling in the finished propellers, all the laminations should be as nearly alike as possible in direction of grain (on the end faces), density, and moisture content. Further, proportion of the moisture should correspond, as nearly as possible, to that of the atmosphere in the locality where the propeller is to be used. These facts have all been taken advantage of in the manufacture of American propellers and their application has done much to enable us to reach the present high standard in propeller construction.

All modern propellers, with one or two minor exceptions, are made by gluing together a number of boards or laminations, which are usually from ¾ to ⅞ of an inch thick. From five to nine laminations are ordinarily used in each propeller. In order to secure satisfactory service it is essential that only the best grades of glue be used. When the United States entered the war, none of the government agencies had had enough experience with glues for a proper glue specification to be prepared or the necessary inspection work to be carried out. The Forest Products Laboratory immediately started the necessary investigations, and drafted a satisfactory propeller glue specification, under which practically all propeller glues for the Army and Navy have been purchased. It also developed methods of making tests and instructed Army inspectors in the proper inspection of glues. The great bulk of glue used in manufacturing propellers was inspected and certified by Army inspectors stationed at the Laboratory.

As has already been pointed out, propellers exposed to varying atmospheric conditions, even when varnished, will absorb or give off moisture, swelling or shrinking in the process. Unless the propellers are made with the greatest possible skill and care, the shrinking and swelling are apt to produce injurious warping and set up stresses which may cause the propeller to fail in service. The need for a coating practically impervious to the transmission of moisture was evident, and the Laboratory conducted several long series of experiments upon many types of coatings, including various shellacs, varnishes, enamels, electroplated metal coverings, valcanite, and several kinds of metal leaf coatings. A coating was finally devised which was many times more effective than varnish coatings in preventing moisture transmission, and this coating has been approved for use by the Army. This coating consists of a layer of very thin aluminum leaf laid on over a layer of partially dry varnish, and then protected with several layers of enamel and varnish. While the coating has no greater resistance to wear than that offered by the varnish and enamel coats over the leaf, it does insure perfect protection to the propeller during storage and shipment and in service until sand or spray wears it off. Since the greater portion of the existence of the average propeller is passed either in storage or shipment, the usefulness of the coating is apparent.

Design of Pressure Plate Anemometers

By C. H. Powell, B. Sc., A. F. Ae. S.
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This instrument has been invented periodically by a number of people. It therefore occurs in many forms all, however, being dependent on the wind pressure on a flat plate or other resisting object, causing the plate to move back against spring or gravity control. Occasionally other resisting forms than a flat plate are used although such substitutions have not necessarily improved the instrument. Also, in some designs the plate moves back parallel to itself as in the spring controlled type, whereas in others it is pivoted at or near one of its edges as in the type shown in Fig 1.

An instrument of this type is somewhat prone to oscillate about the mean reading even when placed in a steady wind, mainly owing to the fluctuating air flow from the plate edges. Some damping device is therefore recommended.

The advantages of such an instrument, however, are sufficient to recommend its application when properly designed to a considerable number of cases, particularly in meteorology. It requires no special setting up and can be made extremely portable. It is, moreover, direct reading, i. e. its speed indications are instantaneous, and the accuracy of the readings is, in the author's opinion, at least equal to that of the moving cup or vane type, in many cases very much better.

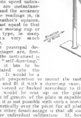

Fig 1

The principal disadvantages are, first, that the instrument is not "self-directing," i. e. it has to be orientated into the wind. It would be a difficult proposition to mount the instrument on a vertical pivot and fit it with a directing vane, for when the instrument veered or backed according to the wind, a centrifugal force would be set up on the plate itself and, as the centre of gravity of the plate is capable of shifting independently, it is not possible with such a moving plate, to mount the c g vertically over the pivot for all plate attitudes.

The other disadvantage is that all such instruments usually require individual calibration. If, however the weights of moving parts and all the dimensions are copied accurately for a batch of similar instruments, it should only be necessary to calibrate one instrument out of the whole batch.

Frequently with the design shown in Fig 1 a removable weight is attached to the plate to enable higher speeds to come within the range of the instrument. Low speeds are of course measured without weight and on a different scale. Care should be taken to ensure that the centre of gravity of the plate and weight together, when the latter is in position, is located at the c g of the plate alone. This is a matter not always attended to by designers of gravity instruments. The combined weight of plate plus weight should also be a simple multiple of the weight of the plate alone. The reason of this is that we are provided with a ready check on the calibrations. This may be seen from the following considerations.

Take one attitude of plate as defined by some particular angle of plate to the vertical.

Let v_1 be the speed corresponding to this attitude without weight and v_2 be the speed corresponding to this attitude with weight.

Suppose further that the plate plus weight, weigh four times as much as the plate alone, and that the c g of the combination is the same as for plate alone, then we have at once, assuming that the square law holds, which is very near the truth for such an object, the following equation

$$\frac{v_2^2}{v_1^2} = 4$$

or

$$v_2 = 2 v_1$$

so that the graduations of the two scales for the instrument with and without weight should correspond.

A further point in the design is that the plate supports should be quite vertical. They should also preferably be thin and placed edge on to the wind to reduce interference between them and the plate. Additional inclined stays or the support should be dispensed with, if possible, on account of air interference.

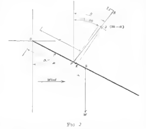

Fig 2

It is interesting to ascertain the form of the function connecting the angle of the plate with the vertical.

In Fig 2 let O be the pivot at the top edge of the plate and G the centre of gravity. Consider the plate at any attitude represented by the angle α. The resultant air force R will act at some such point as P. This may be resolved into normal and longitudinal forces Z and X. Taking moments about O we have

$$Zx = Wp \sin\alpha$$

$$R\cos(\theta+\alpha-90)x = Wp\sin\alpha \qquad \text{Now } R = R_\theta \rho A V^2$$

$$R_\theta \rho A V^2 \cos(\theta+\alpha-90)x = Wp\sin\alpha$$

$$\text{(1)} \qquad V^2 = \frac{Wp}{xR_\theta \rho A} \cdot \frac{\sin\alpha}{\cos(\theta+\alpha-90)}$$

$$V = \sqrt{\frac{Wp}{\rho A}} \cdot \frac{1}{\sqrt{xR_\theta}} \cdot \sqrt{\frac{\sin\alpha}{\cos(\theta+\alpha-90)}}$$

For a square flat plate $\cos(\theta+\alpha-90)$ is for all practical purposes $= 1$, i e the resultant is practically normal to the plate so we have

$$\text{(2)} \qquad V = \text{Const}\sqrt{\frac{\sin\alpha}{\frac{x}{C}R_\theta}} = \text{Const}\sqrt{\frac{C\sin\alpha}{xR_\theta}}$$

where C = length of plate

A table supplying the values of sin α, R_θ and x/C is given below, x/C being the ratio of c p distance from leading edge to the side of the square

The values for R_θ and x/C are taken from M. Eiffel's researches on a square plate.*

The columns headed V_1 and V_e in both tables give the speeds corresponding to the various angles of plate to the vertical for an instrument of this type.

V_e is the actual speed from some experimental results with an instrument having a plate very nearly square.

V_t is the calculated value $=$ Const. $\sqrt{\frac{C \sin\alpha}{xR_\theta}}$

where the Const. has been taken as 6.68

Experimental and calculated values of V are plotted together in Fig 3.

The experimental pt. at $V = 7$ and 15 deg is not an experimental error but is due to the interference of the support stays. Repeated readings were taken to confirm this.

EXPERIMENTAL VALUES

V_e m p h	α
2	1
4	8
5	9.5
6	14
7	15
8	23
10	22
12	38
13	50
14	63
15	65
20	71

CALCULATED VALUES

$\alpha°$	Sin α	x/C	R_θ	$\sqrt{\frac{C \sin\alpha}{x R_\theta}}$	V_t m p h
10	.1736	.472	.540	.825	5.52
20	.3420	.455	.548	1.17	7.82
30	.5000	.444	.552	1.43	9.56
40	.6428	.435	.563	1.62	10.82
50	.7660	.422	.625	1.71	11.43
60	.8660	.387	.685	1.84	12.3
65	.9063	.362	.558	2.23	14.8
70	.9397	.344	.432	2.55	17.1
80	.9848	.257	.165	4.43	29.5

The agreement between experimental and computed values generally is very remarkable, the form of the two curves being almost identical.

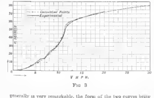

Fig 3

Such being the case, it is now possible to design an instrument straightaway for a given speed range with some certainty of getting the weights and dimensions right first shot without recourse to trial and error methods as hitherto.

* La Résistance de l'Air et l'Aviation, 1911, p. 134

Scratched and Smooth Joints

The common assertion that scratched surfaces make stronger glued joints than smooth surfaces seems hard to prove. Comparative tests made on several occasions by the Forest Products Laboratory all indicate that the strengths of these two types of joints are practically the same.

The test specimens used by the Laboratory were pairs of hard maple blocks, some with smooth and some with tooth-planed contact surfaces. These blocks were glued with a high grade hide glue, allowed to stand for a week, and then sheared apart in an Olsen universal testing machine. Four joints of each type were compared in a single test.

Eleven such tests gave the following average results:

COMPARATIVE STRENGTH OF SCRATCHED AND SMOOTH JOINTS

Test No.	Scratched Joints: Shear Strength lb /sq in.	Scratched Joints: Wood surface in failure per cent	Smooth Joints: Shear Strength lb /sq in.	Smooth Joints: Wood surface in failure per cent
1	1787	25	1855	
2	1386		943	
3	1978		3086	50
4	2409	75	1571	25
5	2298	100	2418	100
6	1947	75	1878	62
7	2310	12	1800	
8	1835	100	2455	100
9	1425		2180	25
10	2330		2294	82
11	2180		2320	75
Gen Avg.	1988	35	2040	47

It will be noted that in seven of the eleven tests smooth surfaces gave the better adhesion. Consequently it would seem that there is no advantage in tooth-planing wood for gluing purposes.

The Turbo Compressor

From a close survey of aerial fighting prior to American participation in the war, it was clearly evident that supremacy in the air was largely dependent on ability to attain greater heights than the enemy, and to develop greater speeds at altitudes. A well-indicated method of achieving this was to develop some means of super-charging the airplane in order to compensate for the decrease in density of the atmosphere with increase in altitude.

That the problem of maintaining a constant atmosphere pressure to the carburetors of the airplane engine is a difficult one, is evidenced by the fact that although experimental and research work was instigated by England, France and Italy independently of one another soon after the war began, none of the devices experimetd with by the Allies was sufficiently developed at the time hostilities ceased to be anywhere near ready for production. In this country development was entrusted to Mr E. H. Sherbondy and to Dr. S. A. Moss. Both investigators concentrated on the exhaust-gas-driven-turbine and inter-connected compressor system of supercharging as originally developed by M. Rateau, though their designs show marked differences.

The B. F. Sturtevant Co., working on entirely independent lines, developed a mechanically driven compressor, which has certain points of advantage. Both types of drive and the compressor are fundamentally simple in principle. The difficulties arise in the mechanical application. The enormous speeds required in the small compressor, the effect of the hot gases on the turbine blades, the problems of stresses set up in the rapidly-moving mechanism due to sudden variation in the engine speed, all give great practical difficulties.

There is reason to believe that all three workers are on the point of attaining success. When success has been reached, the effect on the development of the airplane will be wonderful. Simple mathematical considerations will show that if constant power is maintained, speed at altitudes will be increased by about 30 per cent to 50 per cent above that at ground level. Ceilings will be about 20 per cent greater. Climb will be improved throughout the working range. Such results will mark a new era in aeronautics.

Course in Aerodynamics and Airplane Design

Part III.—Experimental Aeronautical Engineering

By Alexander Klemin

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Section 3. Fuselage Testing

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Theoretical Principles—There are two possible methods in the testing of fuselages

(A) testing the fuselage for air loads on tail surfaces only

(B) testing the fuselage for air loads on the tail surfaces in combination with dynamic loads.

Considering air loads, while in English practice it is customary to test with air loads only, neglecting dynamic effects, and while this is by far the simplest method, yet it

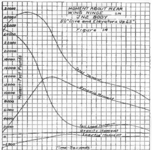


Fig. 1. Moment About Wing Hinge on JN 2 Body

would seem much more reasonable to employ a system which imposes both air loads and dynamic loads on tail surfaces.

In a recent report the author has dealt in some detail with the forces to be found in diving and looping, by a step by step integration, the equations of motion not being capable of solution by ordinary methods of differential equations. For reasons dealt with in previous sections, it is in looping and diving that the fuselage is subject to the severest air loads.

At the end of a long steep dive, the pilot throws his elevator hard up, so as to make a quick recovery. At that moment the entire load on the fuselage is that due to the tail surfaces. As the machine flattens out, describing a circular path, dynamic forces enter into play and the angular velocity produces a damping moment which diminishes the effective force on the tail loads. There are also to be considered at any moment inertia forces and gravity forces.

Fig. 1 taken from the above mentioned report, gives an idea of the relative magnitudes of these forces, at short intervals after the commencement of the recovery from the dive. The forces on the tail produce large moments with comparatively little shear on the fuselage, while the dynamic forces produce

Fig. 2. General Arrangement of Supports for Sand Testing a Body

mainly shear, particularly if they are due to a heavy load concentrated near the rear wing hinge.

In the particular instance given above of a Curtiss JN 2, with a weight of 1800 lb., a wing area of 384 sq. ft., and a stabilizer and elevator area of 42 sq. ft., the airplane was as-

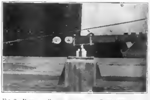


Fig. 3. Ball and Socket Support for Sand Loading of Body and Tail Surfaces

sumed to be in a dive of 50 deg., and to have attained a limiting speed of 123 m.p.h. At this point the elevator was assumed as being turned up to an angle of 25 deg. to the stabilizer, an extreme condition, but one which might well be realized for a machine of this type. It should be noted that as the angle of incidence on the dive increases, the stabilizer assumes a lesser

negative angle to the wind, and if the elevator is maintained at the same angle to the stabilizer both the total force on the tail surfaces and the moment about the elevator hinges diminishes. The latter decrease means that it will become comparatively easy for the pilot to maintain this elevator position.

From the curves of Fig. 1 it is seen that the maximum total moment occurs .24 seconds after the beginning of the pull out. The stresses in the body are a maximum at this time. The greatest factor producing body stress is the moment due to tail load which is 72 per cent of the total moment of 31,400 ft. lb. This corresponds to a tail load of 1430 lb. or, with 42 sq. ft. of

Fig. 4. Failure of Longeron and Planking

tail surface, an average of 34 lb. per sq. ft. The dynamic moment due to centrifugal force is still considerably below its maximum value being at this time 8700 ft. lb., which is approximately 4.34 times the gravity moment about the rear wing hinge.

At 5.1 seconds after the beginning of the pull out, the moment due to the tail surfaces has diminished somewhat, while the dynamic moment is now 7.2 times the gravity moment, which is always small.

For no two machines would the possible tail loads and possible dynamic loads bear to each other a similar ratio, decrease

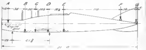


Fig. 6. Distribution of Test Load

and increase in a similar manner. The above curve gives a very fair idea of what occurs, and a good estimate of loads on tail surfaces and dynamic loads to be allowed for in design.

In practical strength testing an arbitrary standard is set up, a loading of 5 lb. per sq. ft. on the tail surfaces being taken to correspond to a dynamic factor of unity. Although this may not give the most satisfactory criterion for all cases, yet it takes care of shear forces and bending moments, whereas a test embodying loads on tail surfaces alone would not touch shearing forces at all.

Practical Methods for Testing Fuselage with Air Loads on Tail Surfaces Only—In British practice it is customary to neglect all dynamic effects, and to test for air loads alone, supporting the fuselage at the rear wing hinge and tying down to the floor at the front end, as shown in Fig. 2.

In testing the fuselage the tail surfaces are dismounted and loads applied on a platform as indicated, one point of attachment of the platform is placed in line with the elevator hinge, and the other point of attachment at the front attachment of the stabilizer. The loads are distributed on the platform in such a manner that the rear suspension takes up the equivalent of all the load on the elevator and half of the stabilizer load, while the front suspension takes up half the stabilizer load.

In actual flight the air loads would be taken up partly at the rear wing hinge, partly at the front wing hinge, partly on the lower longerons, partly on the upper longerons. The single point support as in this case, therefore imposes a very severe and unjustified local strain on the fuselage. To minimize this a ball and socket joint support is used as shown in Fig. 3. In

Fig. 5. Failure of Lower Longerons By Buckling

tabulating deflections, allowance has to be made for the slackening of the cable and the consequent turning up of the fuselage about the hinge point.

During test the loading platform suspended by the rear of the fuselage is normally supported by jacks while the loads are applied in accordance with the loading schedule. The jacks are then lowered until they no longer support the platform,

Fig. 7. Failure of Upper Longeron Butt Splice

which is thus suspended from the rear of the fuselage. Deflections are determined by means of the usual adjustable measuring sticks.

The jacks are then raised to support the platform, while the next increment of load is applied. The jacks are never lowered more than an inch below the loading platform when the latter is fully suspended from the fuselage. Thus when failure occurs, the platform falls through a very short distance only and complete collapse or wreck of the fuselage under test is prevented.

Practical Methods of Testing with Allowance for Dynamic Loads—In addition to the assumed standard loading of 5 lb

per sq. ft. corresponding to a dynamic load of unity, a further standard assumption must be made in order not to localize reactions on the rear support With the large loading on the tail surfaces, the reactions on the rear support are always heavier than the proportion which the rear wing spar would bear in the air It is exceedingly difficult to make an exact correlation between the air and sand test conditions in this case, and to take all factors into account Hence a conventional loading is generally adopted by which one-fourth of the total load is applied at the front support of the fuselage and the remainder at the rear support

In this method of testing the fuselage is supported by short lengths of cables running in the direction of the lift wires and held by a suitable stand, as shown in Fig 4. Fig 5 illustrates the same fuselage loaded with pig lead at point of failure

In Fig 6 is shown a typical load distribution diagram for a Bristol fuselage. The weight schedule of this machine and the loading schedule are given below as an illustration of this method of loading

TABLE I —WEIGHT SCHEDULE (LB)

Fuselage (veneer type)	163	
Fuselage (truss type)		218
Propeller		65
Radiator and water		195
Motor with water in jacket		650
Oil and tank		56
Chassis		125
Gasoline and tank		430
2 Marlin guns, sights, mount, etc		90
1000 rounds ammunition		66
Instruments and board		15
Controls		20
Pilot and gunner		340
Seats, belts, oxygen tanks, masks		43
2 Lewis guns, mounting		56
970 rounds ammunition		79
Tail skid		8
Empennage		43
Total	358	2445

TABLE II —LOADING SCHEDULE

Load No	Dynamic factors	Tail Load lb. sq ft	A	B	C	D	E	F	G	Total Load on Fuselage (lb.)
			Loading Schedule (lb)							
1	2	10 0	1890	1356	280	980	640	136	468	5098
2	2 5	12 5	2075	1695	350	700	800	170	585	6373
3	3	15 0	2490	2034	420	840	960	204	702	7648
4	3 5	17 5	2905	2373	490	980	1120	238	819	8923
5	4	20 0	3320	2712	560	1120	1080	272	930	10198
6	4 5	22 5	3735	3051	630	1260	1440	306	1056	11473
7	5	25 0	4150	3390	700	1400	1600	340	1170	12748
8	5 5	27 5	4565	3729	770	1540	1760	374	1287	14023
9	6	30 0	4980	4068	980	1680	1920	408	1404	15298
10	6 5	32 5	5395	4407	910	1820	2080	442	1521	16574
11	7	35 0	5810	4746	980	1960	2240	476	1638	17848
12	7 5	37 5	6225	5085	1050	2100	2400	510	1755	19123

Results of Typical Fuselage Tests—As a rule fuselage designs show up quite well and are much stronger relatively than tail surfaces. In Table III are given results for a wide variety of fuselages.

Photographs of Typical Failures—Figs 4, 5 and 7 illustrate some typical failures, which we shall discuss briefly

Fig 5 shows the buckling of the lower longerons in a fuselage of the ordinary truss type for an advanced training machine The longerons were 1 in. x 1 in spruce in section, and in the panel where failure occurred 30 in between points of support The spruce was of excellent quality and yet did not develop the full strength of 3350 lb in compression which Navy specifications for a spruce strut with fixed ends, the actual strength on sand test being only 2240 lb Part of this lack of strength may be due to the curvature of the longerons themselves which goes to increase the buckling tendency of the struts. But the more probable cause is that a longeron is not precisely a fixed-end column between the two points of support, so that our usual design assumptions may be unduly favorable The author has drawn a similar conclusion on other tests

In Fig 7 is shown a tension failure in the upper longeron splice of a DeH-4 under a load of 40 lbs./sq ft on the tail surfaces. Although this may be considered ample, yet with subsequent reinforcement of the splice, at the expense of a few ounces extra weight gave a strength of 50 lbs /sq ft on tail surfaces

A typical veneer fuselage failure is shown in Fig 4. It is in the region of the rear wing fittings that veneer fuselages have to be watched The attachment of the lift wire fittings just at this point the fuselage is also weakened by the cutting away of the upper skin for the cockpit.

Book Reviews

£. s. d. of Flying. By Arthur J Swinton (Aeroplane and General Publishing Co 205 pp 12 illustrations.)

The author deals in a plain, matter-of fact manner with the commercial possibilities of aeronautics. The entire field is surveyed mail carrying, passenger carrying, inspection work, conveyance from rail head or nearest point of civilized communication, sheep ranchers' work in Australia, desert voyages, river flights along the great rivers of the world, etc.

Typical flights, such as London to Galway, are worked out carefully from a commercial point of view, with estimates of initial outlay, depreciation, etc Routes are indicated to cover the entire surface of the globe

Capt Swinton is perhaps too positive and optimistic about immediate possibilities, but is on the whole very careful and certainly stimulating.

A Text Book of Aeronautics By Harman Shaw, B Sc., A R C S (4 folding plates and 159 figures in the text. J B Lippincott Co)

This text-book is well-nigh encyclopedic in its range, covering as it does the entire field of aeronautics. It is a reprint of lectures delivered during the war to officers of the British R. N A S and R A F with certain additions and many illustrations.

The first seven chapters are devoted to aerodynamical theory in brief outline under the usual headings of air flow, wing characteristics, streamline flow, etc The presentation is somewhat brief, but quite sound.

The chapters on structural materials and on construction are far too brief to be of service in practical work, and the contents will be familiar even to a beginner in aeronautics. The chapter on aero engines is very clear and well illustrated, and the same remarks apply to the chapter on airscrews. Instruments are ably dealt with, but the few remarks of Chapter 15 hardly deserve the title of Design of an Aeroplane.

Aerial navigation and meteorology are dealt with in a concise way, and should be useful to aeronautical engineers and pilots who wish to have a sound introduction to these two important subjects.

It is a pleasure for a reader who is not a specialist in Wireless Telegraphy and yet wishes to understand the application of wireless on the plane to see the principles so clearly and completely enunciated

On the whole, the volume, though not too deep, should have an immediate and wide appeal

Aeronautical Patents

ISSUED OCT 1 18

1,280,165—To Warren S Eaton Plainfield N J Aeroplane stabilizer.

ISSUED OCT 8 18

1,280,827—To Gustaf Anderson New York City Flying machine.

ISSUED JANUARY 21 1919

1,291 817—To Thomas M Finley, West Plains, Mo Gyratory Stabilizer and Lifting Propeller

1,291 162—To Everard Richard Calthrop, London, England, assignor to E R Calthrop's Aerial Patents Ltd London, England. Parachute

1 291,989—To Ludwig Marschall New York N Y Airplane

ISSUED FEBRUARY 4 1919

1 293,160—To Walter St John Miller Calgary Alberta, Canada. Controlling device

1 293 312—To Sherman S Benson York Nebr Airplane stabilizer

ISSUED FEBRUARY 11, 1919

1 294,234—To Leon Cammen New York N Y. Airplane

1 294 334—To Charles Eich Hoboken N J Aerial warship

1 294 361—To Lewis Halleck Nash South Norwalk, Conn. Art of flying and method of controlling flying machines

1 294 688—To Millie Taylor Bush Dublin N H Aircraft

1 294 861—To Leon Goldmerstein (now by judicial change of name Leon Cammen) Airplane

TABLE III —COMPARATIVE RESULTS OF TESTS.

Type of Plane	Weight of plane (lb.)	No.	Weight of fuselage (lb)	Length of fuselage (ft.)	Distance from rear lift wire to tail post (in)	Area of horizontal tail surface (sq ft.)	Makeup of veneer skin (F denotes fabric between plies)	Direction of grain in face-plies	Material in longerons	Location of failure	Nature of failure	Dynamic factor causing failure	Total load on fuselage at failure (lb)	Bending moment at rear lift wire at failure (in./lb)	Unit load in lb per sq ft. on horizontal tail surfaces assumed concentrated at tail post necessary to produce an equal bending moment.
2-Seater combat plane	3995	2	200	25'	186	58	1/28 birch 1/28 mahogany 1/28 birch	Transverse	Ash and laminated birch	Bottom skin rear of station 18.	Buckling	3 5	13 690	355 000	31 2
		1	186	25'	186	58	1/28 mahogany 1/12 poplar 1/28 mahogany	Transverse	Spruce	Bulkh'd at station 8 (rear lift wire)	Crushing	4 0	13 357	417 000	36 8
		1	182	25'	186	58	1/28 mahogany 1/12 poplar 1/28 mahogany	Longitudinal	Spruce	Bulkh'd and longerons at station 8.	Tension	3 5	12,325	347 000	30 5
2-Seater combat plane.	2406	1	218	22'	168	46 5	Station 1-11 3-ply elm and birch total 3/16 in. rear station 11 3-ply elm and poplar total 5/32 in.	Longitudinal	Elm	Front plate lift wire fitting.	Lug failed in tension in the eye	7 0	17,848	398 000	51 0
		1	163	22'	168	46 5	F station 1-10 1/18 spruce 1/24 spruce 1/18 spruce rear station 1/24 spruce 1/24 spruce	Longitudinal	Ash forward spruce rear	Testing stand failed before fuselage failure		6 0	18,330	371 000	47 8
		1	1[illegible]8	2[illegible]	168	46 5	Station 1-10 1/16 spruce 1/24 spruce 1/16 spruce rear station 10 3 plies of 1/24 spruce	Longitudinal.	Upper station 1-9 ash lower and rear upper, spruce	Skin and longerons at rear lift wire at each end	Combined tension and shear	7 0	17 848	398,000	51 0
2-Seater training plane	2800	1	240	23'	188	51 3	F Monocoque-3 plies of 1/16 in spruce one ply longitudinal others slightly spiral.		No longerons	Bottom of fuselage at forward cockpit.	Buckling	None	13 400	418,000	43 3
2-Seater scout	3995	1	254			57 8	Rectangular Truss type		Ash forward spruce rear		Not tested	None			
2-Seater reconnaissance	2940		277	21'	181	45 5	Rectangular truss with veneer panel sides			Fittings to forward part of fuselage	Tension failure of eyes of lugs	None	5 155	295 000	31 3
2-Seater Fighter	3050		2[illegible]				Rectangular truss with veneer reinforcement forward			Longeron splices		None			40
2-seater advanced training.	1890		140	19 5	160	38 4	Rect Truss type			Fourth panel from tail post	Buckling of lower longerons.	None			33 5
2-Seater Reconnaissance	4600		275	25'10"		47 08	Rect truss covered with veneer				Buckling of lower longerons	None			35 5
Single Seater advanced training			174 5	16'		29 5	Rect Truss type				"	5		122,1[illegible]	
2-Seater primary training.	1900			23'	185	28 5	Rect Truss type				"	None		235,500	42 5
Single seater advanced training	1190		236 (complete)	17'11"			Rect. truss type					7	8150		

Pilot Motor Variable Pitch Propeller

By Alfred Vischer, Jr.

The use of airplanes on an extensive scale for purposes of observation and especially for fire control, during the war, brought about the need for a considerable number of wireless transmitting sets for airplanes, such as the SCR 73, designed and developed by the International Radio Telegraph Co. This set is a refinement of the French airplane transmitter an instrument of the rotary gap type.

The SCR-73 is a synchronous rotary gap transmitter and is adjustable to nine wave lengths supplemented by five inde- obtained from interchangeable gap rotors to prevent interference and to aid in identification. Power is supplied by an 18 in wind driven fan attached directly to the generator shaft, running at 4,500 r.p.m.; in this set, which speed must be maintained at that constant rate in order not to vary the pitch of the note.

At first it was attempted to use a fixed type fan, but airplane maneuvers, by bringing different wind pressures to bear upon the generator blades, made this impracticable, breaking the note and at nose dive speed often bringing disaster to the instrument. Variable pitch fans of various types were then tried, also without success. Plans and models of magnetic regulators, friction devices and speed regulators of the direct centrifugal type all had to be discarded, in the first place because they required propeller blades which after having been calculated and constructed had, each and every one, to be carefully calibrated and even then would not be exact enough to give complete satisfaction, and in the second place, because friction in the moving parts and the pressure of varying winds prevented uniform regulation. The result was the production of the Vischer pilot motor variable pitch fan governor, which differs basically from the other speed regulators and does not require a calibrated blade.

This automatic variable pitch propeller, shown in Fig. 1, consists of two balanced walnut blades, linked over a hardened steel ball a in Fig. 2, by two hardened tool steel links, bb, with sufficient clearance to permit a 20 deg. angular movement to each blade. When in operation the blades react on each other, floating in the case bearings. The driving shaft of the generator passes through one link at c, thus centralizing the blade and generator axes. A short flexible arm, d, fixed to each link is the means by which the blade movements are controlled by the governor, thus is plainly visible in Fig. 2.

The blade controlling mechanism consists of a spring-loaded governor, e, one end of which is fixed to the casing and keyed with it to the generator shaft, while the other end floats on an idle spur gear, f, mounted on ball bearings, whose center of rotation is fixed eccentrically to the generator frame. This gear moves parallel to its axis of rotation as the fly-balls of the governor expand or contract.

Fixed to the walnut case, to the rear of the blades, is a metal rim or gear case in which is housed a series of five internal differential gears, three of which are movable, the others fixed to the case. The gears are of 32 pitch and through them a gear reduction of 14,400 to 1 is obtained. From Fig. 3, which shows the arrangement of the internal gears, it can be seen that one face of the idle gear i engages at all times with the wide fixed internal gear of 120 teeth a, while its other face engages with either gear b of 121 teeth or gear d of 119 teeth, or, when at normal speed, runs free opposite spacer c. This spacer is .005 in. wider than the engaging face of i to allow ample clearance. The sensitiveness of the mechanism is controlled by the amount of this clearance. Plate e, gears b and d and spacer c are pinned to one another and it can be readily seen therefore that this train will revolve either clockwise or counter-clockwise with respect to the casing depending on whether gear i engages with d of 119 teeth or b of 121 teeth. On disc e is pivoted the planet gear k, which engages at all times the fixed internal gear f of 120 teeth and the movable gear g of 119 teeth, thus completing the required gear reduction. To gear g is fixed disc h mounting disc l with heavy friction springs in order that h can continue to rotate when l is at the end of its stroke, as will occur at speeds above and below normal. A feature of the construction of the Vischer governor is its perfect symmetry, which eliminates the necessity of any counter-balancing other than for non-uniformity of materials.

Fig. 1

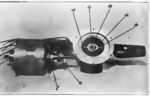


Fig. 2

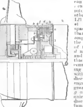


Fig. 3

Operation. When a plane takes the air, its speed will be comparatively low, and gear i engaging d and b forces blades open until a generator speed of 4,500 r.p.m. is reached. At the speed of 4,000 r.p.m. the governor balls, e (Fig. 2), commence to open, drawing gear i away from gear b. When the speed of 4,500 r.p.m. is reached, the governor has opened to a neutral position in which one face of gear i is opposite spacer c, and therefore no further change in blade angle takes place. Any slight variation in the speed of the fan due to sudden changes in the speed of the plane or to changes in electrical load, cause the governor i (Fig. 2) to draw gear i into mesh with either gear b or gear d depending on the sense of the variation. This shifting of gears is brought about easily because the peripheral speeds of gears a, b, d, and i are very nearly equal.

Thus the blades automatically take a position to maintain the speed of 4,500 r.p.m. regardless of the rate of travel of the airplane. As the plane goes faster or slower, the fan-blades by means of the pilot governor automatically adjust themselves to maintain 4,500 r.p.m.

The gear ratio is calculated to vary the blade angle from maximum to minimum in eleven seconds. Slight changes in speed due to variations in load on the generator while transmitting messages are effectively adjusted by the pilot governor, which sets the blade angle correctly no matter what the cause of the change in speed, whether due to wind pressure, change in load, blade form or any other cause.

Test. To test the governor for proper speed regulation, it is necessary only to check the r.p.m. of the governor against the stroke of gear i, which must be one-half its entire stroke at 4,500 r.p.m.; in other words when in operation gear i must be opposite spacer c at 4,500 r.p.m.

Experiments are now being conducted preparatory to the use of the pilot motor variable pitch propeller to produce a constant torque airplane propeller.

A Mail Flight in the Storm

The operation on schedule of the Aerial Mail Service between New York and Washington has become such a matter of fact that it no longer attracts attention. It is little realized what an amount of energy and professional skill this service demands from the mail pilots. The story of a flight recently made by mail pilot John M. Miller under most adverse weather conditions is told in the report made by the aviator to the Second Assistant Postmaster General, which is reproduced herewith.

Bustleton, Pa.,
March 29, 1919

Second Assistant Postmaster General,
Washington, D. C.

Reference to your wire No. 4, March 29, 1919.

Subject: Report of flight from Philadelphia to New York, March 28, 1919.

Left Bustleton at 2:15 p. m. March 28, 1919, in plane No. 30, Curtiss R-4. Wind velocity, reported by Philadelphia Weather Bureau, 48 m. p. h., direction approximately 300 deg. Climbed to 3000 ft. before reaching Trenton. Steered compass course of 25 deg., allowing 40 deg. drift angle. Severe bumps felt at all altitudes. Looking ahead snow could be seen. Directly to the rear, atmosphere clear. Passed over Trenton at 2:30. Having a short time before run into snow, which made it necessary to fly at 1,000 ft. at which altitude could just see the ground. Could not see enough of the ground to recognize any landmarks. Flew entirely by compass.

The next landmark picked up was the Woolworth Tower, New York City. Passed over it about 300 ft. to the North, altitude about 900 ft. No very severe bumps felt directly over the city, but when passing over Brooklyn very severe bumps were encountered. These threw the plane about to such an extent that I was unable to watch my compass for several minutes. Extreme aileron and rudder were needed a number of times to bring the plane back to normal flight. Flew with motor wide open during this time (1600 r. p. m.). The snow became heavier, and in order to see the ground had to fly below 500 ft. The air continued very rough and was only able to look at compass occasionally. At about 3:05 picked up a railroad and attempted to follow it, thinking that it might lead to Jamaica, but the country was not familiar and it was very difficult to follow the rails. Do not believe I was more than 200 ft. The air was very rough.

At 3:15 decided to pick a field and land. Attempted to do this, but on seeing a field would be driven past and it would be lost before I could turn and land. Then headed around into the wind and flying just over the buildings and trees, approached several fields, but they were all too small. At this point passed over a small body of water and felt the worst bump of the trip. Was not more than 80 ft. and was thrown into a vertical position and back to normal almost before I could use the controls. What appeared to be a fair field was directly ahead. Throttled motor and zumed over a fence. On the farther side the ground rose in a gradual slope and pulled back to land. Just as the wheels were about to touch, a current of air coming from the other side of the hill caught my plane and lifted it about 20 ft. Then the plane settled vertically to the ground, crushing the landing gear and breaking the propeller. This occurred at 3:20 p. m. on a field owned by John C. Baker, Great Neck, L. I.

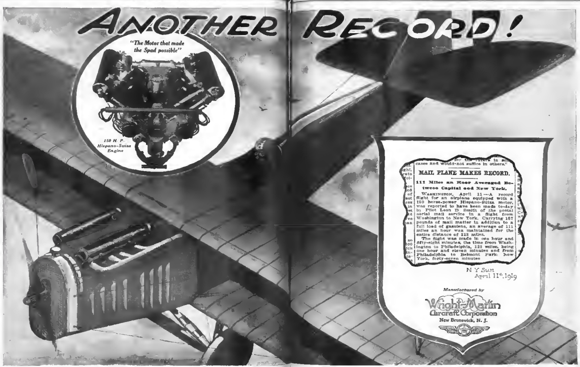
While passing over Brooklyn the motor cut out three times. Turned on the gravity tank and it picked up again immediately. Then shut off the gravity tank each time it came back. Presumably this was caused by the severe bumps. One pocket over Brooklyn let the plane drop approximately 100 ft. It was so rapid that I was thrown full weight against the safety strap. Motor revolutions per minute, 1450-1600, temperature, 150-160, oil pressure, 35. All parts of the plane and motor worked O. K.

After landing secured a watchman and took the mail to the Great Neck railroad station in Mr. Baker's car. Advised Manager, Belmont Park, that I had landed. Took train for New York at 4:12 p. m. Arrived Pennsylvania Station at 5 p. m. and was met by railway mail service clerk. Returned to Philadelphia, by order of Mr. Praeger, on train at 5:30 p. m.

(Signed) John M. Miller.

French Airplane Ambulance Fitted With Complete Hospital Equipment for All Emergency Cases

(c) Keystone View Co.



ANOTHER RECORD!
"The Motor that made the Spad possible"
150 H. P. Hispano-Suiza Engine
MAIL PLANE MAKES RECORD.
111 Miles an Hour Averaged Between Capital and New York.
WASHINGTON, April 11.—A record flight for an airplane equipped with a 150 horse-power Hispano-Suiza motor, was reported to have been made to-day by Pilot Leon D. Smith of the postal aerial mail service in a flight from Washington to New York. Carrying 157 pounds of mail matter in addition to a full load of gasolene, an average of 111 miles an hour was maintained for the entire distance of 213 miles.
The flight was made in one hour and fifty-eight minutes, the time from Washington to Philadelphia, 122 miles, being one hour and eleven minutes and from Philadelphia to Belmont Park, New York, forty-seven minutes
N Y Sun
April 11th, 1919
Manufactured by
Wright-Martin Aircraft Corporation
New Brunswick, N. J.

The Halberstadt Two-Seater Fighter*

The Halberstadt represents, in all probability, the highwater mark of two-seater German airplane construction, as it is not only well and strongly constructed, but its general behavior in the air is good according to modern fighting standards.

The most notable constructional features of the Halberstadt are resumed herewith

Wings—The construction of the wings is of considerable interest, especially on account of the novel type of spar which is employed in both upper and lower wings. The front spar measures 2¾ in by 1 in., and at the butt is placed about 4 in from the leading edge. It is of "I" section, but is left full at such points as those at which internal bracing wires are fixed, it is connected to the leading edge by means of plywood, both top and bottom.

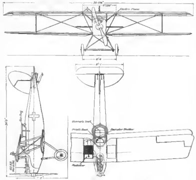


Fig 1 Outline Drawings of the Halberstadt Two-Seater Fighter

A section of the rear main spar is given in Fig 2 In this case the main member is of "O" or box section, and is built up of two pieces let into one another in a rather unusual manner Both at the top and bottom of the spar thin strips of wood are used to cover the glued joint, and on the inside are tacked, both above and below, a flat length of ply wood 7 in wide which overhangs the main member of the spar an equal distance at each side.

This ply-wood web is flanged at each end with strips of wood glued in position, and on these strips are fitted small corner pieces which serve to support the ribs The latter are also of ply-wood, to which are glued and tacked rails of solid wood, top and bottom

A notable point of the wing construction is the fact that steel tubes are not used as the compression members of the internal bracing, as is the common practice These members are made of box form ribs which occur at intervals along the spar. Adjacent to the root of the wing a very large reinforced box rib occurs, of which the section is given in Fig 3

Wing Attachments—The whole of the center section both upper and lower surface, is covered with three ply wood, and the spars used in it are of similar design to those fitted to the wings Both the upper and lower wings are provided with attachments which allow of their being very readily taken down Views of these fittings are given in Figs 4 and 5, the former showing the attachment of the upper wing to the center section, and the latter that of the lower wing to the fuselage In the former case, the fitting is covered in with a spring operated trap-door which also gives access to the joint of the aileron control shaft A sliding door is used in the lower plane, and it will be noticed that the spar is at this point protected by an aluminum foot plate In each case quick, detachable safety bolts are employed Fig 6 illustrates the type of spar socket in use This is built up of sheet steel and oxy-acetylene welded, the quality of this work appearing to be very high

The spars of the lower wings engage with a fork-ended tube passing right across the floor of the body and supported by the longerons of the nacelle by means of sockets.

Struts—The struts throughout this airplane are of streamline steel tube of light section, but in contradistinction to the usual German practice they are not tapered at the ends, but end abruptly as shown in Fig 7 This form of construction has the advantage of lending itself very well to the saving of labor, as the struts are simply lengths of plain tubing pierced with transverse holes and reinforced by welded shoulders where the latter occur The struts are secured top and bottom by bolts and eyes, and it will be noticed that where a cross-bracing wire has to be taken from the junction, the turnbuckle is neatly anchored to a small pin passing through the rear of the tubular strut, which is slotted and slightly expanded at this point

The bolt hole is also reinforced by spot welding This arrangement of strut attachment appears to be very practicable and certainly looks extremely neat

The upper ends of the inclined center section struts are fitted with a different type of anchorage, as in this position the simple form of attachment used on the interplane struts cannot be adopted. A sketch is given in Fig 8, from which it will be seen that the end of the strut is welded up solid and fitted with a scooped-out slot for the reception of the diagonal wire which runs to the bottom of the body

Body—The body is constructed of four main longerons fitted with skeleton bulk-heads at intervals and covered in with three ply wood The bulk-heads are of a very light construction except that adjacent to the tail, which serves as the main support of the rudder post and tail plane spar At this point the bulk-head is made of multi-ply wood, and is extensively fretted The rudder post is fixed to the bulk-head by sheet steel brackets.

Another notable feature of the body is the fact that the pilot's and gunner's cockpits are made in one without apparently introducing any weakness into the construction This scheme has the advantage of permitting the pilot and passenger

* Excerpt from a report issued by the Technical Department of the British Air Ministry

to sit very close together, so that the length of the body is reduced

The gun ring does not, as in the usual design, form an integral part of the body cowling, but is fitted thereto by streamline steel brackets.

Fig 2

Fig 3

Tail Plane—The mounting of the tail planes is carried out without the use of any external wiring or cross bracing The fixed tail planes are built up of steel tubes and have a section curved both top and bottom The rear spar, which acts as part of the hinge of the elevator, is carried in a pair of built-up welded steel brackets, which form the end piece of the body The front spar, which is slightly in the rear of the leading edge, is capable of being adjusted when the machine is on the ground, so as to vary the angle of incidence of the tail planes The adjustable clip for this purpose is shown in Fig 9 and gives a choice of four positions

Vertical Fin and Rudder—The method of construction of the vertical fin and rudder is a combination of wood and steel

Fig 4

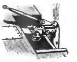


Fig 5

construction The ribs of the fin, which is curved in section and has a rounded leading edge, consist of thin steel tubes, 8 mm. in diameter, welded to the leading spar and taken back to the rudder post at a slight angle to each other. This staggering of the tubes gives the rib the thickness of a single tube only at the trailing edge They are reinforced with diagonal tubes of 5 mm in diameter The leading edge is formed by a covering of thin three-ply wood supported by a light wooden framework.

Ailerons—The ailerons are of the balanced type and are fitted on the upper plane only They are furnished with the usual welded steel framework and are very light in weight. Their method of operation differs from that found on any other German design The aileron front spar, which is hinged to the rear spar of the wings, is continued inward by means of a tubular steel extension until it reaches a point level with the side of the body. Here the extension of the shaft terminates in a crank which is operated direct by the "T" shaped control lever through the medium of vertical steel rods

Fig 6

Control Gear—The control gear is of the usual type, with central lever and foot bar The lever is fitted with a locking device whereby the incidence of the elevator can be fixed at will. This consists of a light telescopic tube mounted diagonally and fitted with a clamp, operated by a thumb screw

It is worthy of note that while none of these controls are duplicated the elevator cranks are fitted with two sets of bolt holes, so that the leverage can be adjusted if necessary

Undercarriage—The undercarriage consists of a steel axle, which is supported from a pair of tubular steel struts at either side by means of triple steel coil spring shock absorbers and carries 760 by 100 wheels.

At their upper ends the struts are bolted to one of the bulkheads, as shown in Fig 10, while the lower ends are

Fig 7

Fig 8

welded together into a knee joint They are reinforced at the latter point by a tie-rod, the sockets of which are slotted to afford passage to the bracing wires

The tail skid is of ash, reinforced with a built-up steel steel shoe, and rubber sprung

Power Plant—The engine is a high-compression 160 hp Mercedes (commonly known as 180 hp) The engine bearers are of wood and are directly supported by the forward bulkheads

Gasoline Tanks—The main gasoline tank is situated under the pilot's seat, and has a capacity of 24 gal This is fed to the carburetor under air pressure, and the usual hand and engine pumps are employed.

The second tank is let into the upper surface of the center

Fig. 9

Fig 10

section of the top plane, and contains 8 gal It is fitted with a glass tube, lying parallel to the upper curvature of the plane, by which the pilot can readily see the level of the fuel This gravity tank can be filled from the main tank by means of a semi-rotary hand pump

Radiator—The radiator forms part of the right hand side of the center section, and is fitted with a small subsidiary water tank, which is provided with a trumpet nozzle pointing forward (Fig 11) The radiator shutter consists of a sliding panel of sheet steel mounted on a light tubular frame-work forming rails. This is within easy reach of the pilot, and can easily be slid forward or backward when it retains its position by reason of the lift effect upon it, and the friction between the guides and the rails.

Fig 11

Oil—A supply of 5 gal. of oil is carried in a small tank fitted at the side of the engine The latter is furnished with a pump which, while circulating the lubricating oil contained in the tank, draws a small supply of fresh oil from the tank at every stroke

Airscrew—The airscrew has a diameter of 2 40 m. and a pitch of 2 00 m ; it is built up of five laminations of ash and three of mahogany.

Wireless—The airplane is internally wired to give greater capacity for wireless, and accommodation is provided for the aerial and its spool in the observer's cockpit The wireless dynamo, which also provides current for electrically

heating clothing, is driven from a pulley on the engine, and is mounted on a bracket carried by the left hand engine bearers.

Level Indicator—The level indicator is of a type not previously found on German airplanes. It consists of a pendulum device, operating a circular disc, the lower half of which is covered by a semi-circular metal shield. The upper half of the disc is dark in color, though not quite so dark as the shield, and below its horizontal diameter the swinging disc is painted white, so that if the machine sideslips a white sector becomes visible against a dark background.

SPECIFICATIONS

Span of upper plane, 35 ft 3¼ in.; span of lower plane, 34 ft 11 in.; chord of upper plane, 5 ft 3¼ in.; chord of lower plane, 4 ft 6½ in.; gap maximum, 4 ft; gap minimum, 0 ft 8⅝ in.; dihedral angle of lower plane, 2 deg.; horizontal dihedral of main planes, 4 deg.; total area of main planes, 316 sq ft.; area of each aileron, 11.6 sq ft; area of aileron balance 2 sq ft; load per square foot, 8.2 lb.; area of horizontal fins, 12.6 sq ft.; area of elevator, 12.4 sq ft.; area of vertical fin 6.4 sq ft.; area of rudder 7.9 sq ft.; area of rudder balance, 2 sq ft.; maximum cross section of body, 4.8 sq ft.; area of body, 44 sq ft.; vertical area of body, 62.8 sq ft.; length over all, 24 ft.; engine, 180 hp. Mercedes; weight per hp. 14.07 lb.; capacity of gasoline tanks, 34 gal.; capacity of oil tanks, 6 gal.; crew, 2; guns, 1 fixed and 1 movable; military load on test, 545 lb.; total load on test 2,532 lb.

PERFORMANCE

Speed at 10,000 ft., 97 m.p.h. 1385 r.p.m.

	Mins.	Secs.	Rate of Climb in Ft./Min.	Indicated Air Speed
Climb to 5,000 ft	[illegible]	[illegible]	440	60
Climb to 10,000 ft	24	35	[illegible]	[illegible]
Climb to 15,000 ft	[illegible]	[illegible]	[illegible]	55

Service ceiling (height at which climb is 100 feet per minute) 18,500 ft.
Estimated absolute ceiling 19,800 ft.
Greatest height reached 18,600 ft. in 64 min. 40 sec.
Rate of climb at this height 50 ft. per min.

Some Ideas on Airplane Production

By Harlan D. Fowler

From a production standpoint attention should first be directed to standardization. Standardization must be considered under two headings, that connected with the allied industries, such as bolts, nuts, screws, washers, cotter pins and other similar units which are universally used in all forms of aircraft or automotive construction, and that pertaining to parts that are usable in the individual airplane only, i.e., cannot be utilized in another type. At the beginning of the war little had been done in the matter of standardization, and it was not until particular attention was directed towards the standardizing of aircraft units and materials that aircraft production began to increase.

Close attention must be placed upon the utilization of as few kinds of materials and units as possible. The reason for this is readily grasped when it is realized that it is much easier to turn out by automatic machinery a few sizes of bolts and nuts than a great number of sizes which necessitate numerous changes of dies and taps. For instance, on an instrument board it was found that each instrument was attached to the board with different sized screws, due to the fact that each manufacturer decided upon the size screw to hold his instrument to the board. This has now been standardized and only one size screw is necessary.

The above example is minor compared with the actual construction of the fuselage and wings. In these parts so many pieces are involved in the making of assemblies, that hundreds of screws, bolts and nuts are necessary to hold them together. The impossibility of securing a certain size bolt would, in some instances, compel the holding up of production of an entire plant. Many instances may be cited in which No. 10 bolts were used, when the ¼-in. bolt would have been just as well, if not better. The ¼-in. bolt was already being used quite extensively in aircraft construction and due to this fact it was more easily procurable than other sizes. While this method involves a slight increase in weight its proportionate increase to the total weight is negligible, irrespective of its effect on production. It is not the intention of the writer to recommend the use of ¼-in. bolt throughout the greater part of an airplane, as much as it is to recommend the practice of adopting a certain size unit, and employing it as much as possible in the plane. It is merely a question of having the stock room well supplied with great quantities of a few sizes of standard units, instead of bins and bins of odds and ends.

An example of individual standardization is afforded by the case of wing rib construction. On a machine, it was found that nearly every rib was differently built up, that is, some of the cap strips were routed, of these some had different width of routing, some half routed, and some not routed at all, this, in turn made it necessary to have webs with different contours and thicknesses. The result involved fifteen different designs. After careful study the number of designs were cut down to eight, thus saving nearly fifty percent on wing rib production, and still preserved the wing's original strength.

Materials

A field deserving of intensive study is that in regard to materials. The proper selection of a certain kind of material should be based, first, upon its suitability for the design under consideration, and second, upon its procurability in the open market. It often happens that it is impossible to secure certain specified tubing as called for on the drawing, and the engineer is thrown upon his resources to decide upon a substitute, the result often being that he chooses a less highly specified tubing and increases the gage in order to obtain the required strength. Sometimes such a procedure is unwise and necessitates another design. Weight figures prominently in all metal designs and therefore designs involving the use of metal should be given much thought.

Forgings are expensive and consequently consideration should be devoted to a design looking towards the elimination of all forged parts as much as possible. The greatest disadvantage of having parts made from forgings is that they require some means of attaching them to another unit, such as welding or brazing, and therefore attention must be directed to condition of stresses where that part might be subjected to. Sheet steel, aluminum, and copper are good materials. Their adaptability to stamping, bending and spinning, together with reliable strength, has fostered their use in all airplane construction. Attention must be devoted to the employment of certain gages. It sometimes pays to use a heavier gage, in order to secure the material, and then lighten up with holes if possible. The use of aluminum in sheets and tubing is becoming more and more popular, especially with the recent advent of high strength aluminum alloy, giving, in some cases, a strength almost equal to that of steel. Tubings taken from the Zeppelin airship frame work gave a tensile strength of 50,000 lb. and we now have better than this. The amount of elongation and reduction of area for aluminum alloy used in test pieces compares favorably with similar tests made with steel pieces.

Spruce is truly a wonderful wood for airplane construction, but its use must be controlled on account of the lack of supply—which applies when production is enormous. Under such conditions fir or poplar can be used, and often pine. Laminated wing beams have been a big help in securing production by enabling the utilization of a partially defective piece of wood. Ash should be discreetly employed, because it is not easily procurable and also on account of its comparatively greater weight.

Veneer, commonly known as ply wood, is today the most universally used material on the market for airplane construction. Its strength and its weight are excellent for both construction and bracing purposes, due to its construction ply-wood tends to reduce natural distortion.

Flux and Heat Treatment

Methods of joining metal to metal by means of furnace welding, electric welding and brazing must be given strict attention. The fact that the metal part is subject to a sort of adulterated heat treatment due to the necessity of applying these methods is in itself a drawback, especially in the case of brazing. Suppose it was found that a certain grade of fabricated sheet steel was given a heat treatment of 1550 deg. Fahr. and that another piece is to be attached with brazing material requiring 1475 deg. Fahr. temperature to bring it to a melted state. The application of this inferior heat, even while slight and purely local, will tend to case harden the fabricated part at that point. If there is a wide difference in temperature between the heat treating and the brazing of the pieces and the completed fitting is subjected to vibration, it will eventually crystalize and suddenly fail under severe conditions. It is therefore better to subject the fabricated part only to such heat treatment as may arise from brazing or welding. This rule should not be rigidly followed, as some cases will arise where the fabricated part should be given heat treatment previous to brazing or welding other parts on. Soldering, spot-welding, and dip-brazing should also be carefully considered. It is sometimes found very desirable to employ rivets in conjunction with some of the above joining processes as a matter of precaution, as should the part held by the joining material work loose the rivet will at least hold the parts together until it can be given proper attention. This is especially true with such parts as are integral with the control mechanism.

Spliced Joints and Steaming

Spliced joints in wood members have caused little trouble when the splice conforms with specification. Waterproof glue and tape, when properly applied, will make the splice much stronger than the wood adjacent to the splice. Wood screws may sometimes be used if it is felt that extra precaution should be taken, such as in a tapered member. To do good work with wood, however, the wood must be thoroughly seasoned by placing it in well designed dry kilns and afterward kept stored in rooms in which a constant temperature is maintained. The humidity of the storeroom should be especially watched, as it affects all steam bent pieces. Unless this is properly carried out, the bent pieces will tend to deform and straighten out, causing no end of constructional troubles, and consequently retard production.

Effect of Changes on Production

One of the most difficult problems in production is that due to "changes" or the possibility of a particular design affecting another part or parts. A change is liable to affect the entire characteristics of the plane and its construction. Such an example may be given in regard to changing the stagger of an airplane. This change on a given machine was absolutely necessary and consequently the length of every interplane strut had to be changed, new strut fittings and new lengths of cables were required in the wing construction. Such a change is a great obstacle to rapid production, though minor changes may be effected with the very object in view of increasing production.

Tie Rod Construction

Swaged rod construction has been found to be a good production job, for they simplify construction and help to reduce the weight. Once the secret of making them is mastered they will be easily procurable. Streamline wires are a very desirable element in design, but the manufacturing of them is difficult while their strength is not altogether dependable. It is inevitable that they will be exclusively used as soon as these faults have been remedied. Swaged rods are used extensively in body and internal wing bracings, while streamline wire is used for interplane bracing. The latter must be fastened so that the curved sides will be parallel to the line of flight, as otherwise an excessive amount of head resistance will be set up.

Instrument Board Layout

The location of instruments on the instrument board requires attention. It is most essential for any pilot to locate naturally and easily the more important instruments and not be compelled to search these out in isolated places. It is desirable to have all instruments that directly concern the engine, fuel consumption and cooling, fitted on the right side of the board, and all instruments that pertain to the actual navigation of the airplane on the left side of the board. The compass, however, should be located in the center of the board, near the top, as it acts more correctly in that position. The compass is affected by the movement of the metal stick used in the stick control, therefore the higher up the compass can be placed on the board, the less it will be affected by this influence. The use of a robust hardwood stick in place of steel tubing would eliminate this defect.

Drafting Methods

Drafting room methods will need more attention than has been given to it in the past. Detail designs must be given especial attention and should contain plenty of necessary information, for the making of the piece inserted on the drawing. To accomplish this, close cooperation should exist between the workshop and the engineering force in making the first experimental piece, so that if any desirable information is found lacking on the print this can immediately be corrected. Such practice would eliminate much expense in making future parts.

As an example of this the following may be cited: A print called for a pair of parts whose design was of V-shape construction, and laid off in four different angles, of which two angles were measured in projection. The piece was fabricated according to these angles, although it was assumed at the time that all the angles given measured in the horizontal plane or plan view. The result was that when the parts were nearing completion it was found that only two of the angles were correct and the other two measured less than the supposed horizontal angles. The piece was bad enough to make as it was, but due to this incorrect lay-out of the print, it was necessary to make another pair and the actual cost totaled $75.00 before the perfect pieces were made. The amount of rough stock required for making one piece was about ¾ in. diam. x 9 in. This mistake could easily have been avoided if any cooperation had existed between the shops and engineering office when the original part was made. Several machines had already been made in which this design was used.

Flat patterns and the finished products in bent-up form involve a good deal of labor to make possible accurate lay-out. Some are of the opinion that it is only necessary to make a drawing of the bent up form and from it lay out the flat pattern in the shop, while others believe that only a flat pattern should be drawn up and the bent up to assume its shape in operation. The engine, or nose, plate is an example of intricate design, which requires study of shop practice in order to correctly develop.

Material and Parts Lists

Compilation of parts lists and material lists has always proven of much assistance in production. A material list, when properly gotten up, will not only lessen the cost but also provides a means of ordering material in such quantity and sizes as to greatly reduce the liability of not having enough on hand in times of great production. A card system is very helpful in office work, and more so when the card gives information relative to the kind and quantity of material required, and assembly number to which the part belongs. Cross indexing of the cards in reference to their numerical arrangement, assembly groupings and materials saves much time.

Stock Room

In every case of production problems, the stock room is the biggest bugbear of all. As there should never be a lack of supplies in the bins of the stock room, in order to be able to know instantly whether there is danger of a shortage of a certain part, a continuous inventory must be maintained at the door of the stock room at all times. In such cases of production where thirty machines are completed a day, it is realized how important it is for a foreman to see to it that his men are giving their best to compete with the ever threatening close-down of airplane production, and the engineer who is contemplating the making a change in design must foresee these conditions and be in a position to inaugurate the change without affecting production to the slightest extent.

Conclusion

The summation of this analysis is that an airplane should be a clean and sensibly designed machine, in which the demands for rapid production and the desire for superior performance must be compromised with the present day demand for a strongly, simply and lightly built structure—requirements which do not exclude one another, for there is still much opportunity for originality in construction.

News of the Fortnight

Air Service Reorganization

Consonant with the demobilization of the Air Service and its reorganization on peace footing, the control and administration of the Army flying forces is being recast on the fundamental principle of single control of aircraft production and operation, which is to supersede the cumbersome system of dual control created during the war. The latter plan of organization was but a war measure, destined to pass out of existence six months after the signing of the treaty of peace.

As a consequence of this reorganization, the Division of Military Aeronautics and the Bureau of Aircraft Production disappear in name and are merged in the new organization plan, which is based on the divisional system, while the Director of Air Service, Major-Gen. Charles T. Menoher, is placed in charge of all activities of the flying forces of the Army.

The office of the Director of Air Service will consist of an Executive Staff, composed of an Executive Officer and four assistants. The Executive Officer will be the direct representative of the Director of Air Service, and will have the assistance of an Advisory Board composed of six officers, each of whom will represent an important branch of the Air Service. Col. M. F. Davis has been designated Executive Officer, and Col. W. E. Gilmore, Maj. H. M. Hickam, Brig.-Gen. W. Mitchell and Lieut. Col. W. F. Pearson first, second, third and fourth Assistant Executives, respectively. The Advisory Board is composed of Cols. Walter G. Kilner, Arthur L. Fuller, Henry C. Pratt, Lieut.-Cols. George B. Hunter, B. Q. Jones, and Maj. Charles R. Cameron.

The first Assistant Executive is charged with matters of supply, the second with statistics, information and publicity, the third with training and operations, and the fourth with administration and routine work.

As a compliment to this reorganization, the Aircraft Board, created by act of Congress, approved Oct. 1, 1917, "having accomplished the important purposes for which it was created," has been dissolved by Executive order.

NC Seaplane Division 1

The ocean-going flying boats of the NC class which the Navy is fitting out for the projected trans-Atlantic flight by way of the Azores are nearing completion. Three of the four boats are to participate in the flight, namely, NC-1, NC-3, and NC-4, and these have been officially designated as NC Seaplane Division 1, which will be commanded by Commander John H. Towers, U. S. N.

These boats are of identical construction, with the power plant consisting of four high-compression Liberty-12 engines, which are arranged like in the NC-1, with the fourth engine mounted in tandem with the midwing engine and driving a pusher airscrew. This arrangement is believed to insure a better utilization of the engine power and greater ease of operation than the fitting of the engines in two tandem sets—like on the NC-2—with each set driving a tractor and a pusher airscrew.

The NC-1 is now being refitted with the wings of the NC-2, while the NC-3 is undergoing sea and air tests, the NC-4 is being assembled at Rockaway naval air station. The flight is expected to take place some time in May.

International Air Code

The proposed convention regarding international aerial navigation has been completed by the judicial and military subcommittees of the aeronautic commission of the peace conference, on which Brig. Gen. Benjamin D. Foulois, Major Pollock and Captain Baron represent the United States.

The convention is composed of forty-one articles, which establish an international agreement on sovereignty of the air, provide for the concession of inoffensive voyages between the contracting states and deal with forbidden zones and also international aerial routes.

An international commission on aerial navigation is to be formed. Its duty will be the gathering and disseminating of radio telegraphic, meteorological and medical information.

French Airplane Competition

The French government has issued a preliminary program for an airplane and aero-engine competition which is to be held next year.

The competing airplanes will have to fulfill the following conditions: (a) Safety factor, 6. (b) Theoretical ceiling, 1500 m. (c) Minimum horizontal speed at 1000 m. altitude, 150 km. (d) Maximum wing loading, 38 kg./sq. m. (e) Multiple engines. Where three or four engines are used, a single engine should be capable of maintaining the airplane in horizontal flight.

The competing aero-engines will be subdivided, according to their power, into three classes, namely: (a) from 125 to 150 hp., (b) from 250 to 300 hp., and (c) from 500 to 600 hp. The endurance test will consist of a non-stop run of 300 hr. at 80 per cent of the rated horsepower; airscrew speed is limited to 800 r.p.m., but to enable existing engines to compete, the use of reduction gears will be authorized. The maximum weight allowed for a single engine, complete, with water (where water-cooled), gasoline and oil for a continuous 5-hr. run is 3 kg./hp.

Ball Bearing Manufacturers Combine

Of interest to all users of bearings is the just announced reorganization, effective May 1, whereby the products of The Hess-Bright Manufacturing Co., the S K F Ball Bearing Co., the Atlas Ball Co. and the Hubbard Machine Co. will be sold through one central organization. The new company, under the name of S K F Industries, Inc., will thereby be able to offer a comprehensive line of ball bearings, including the Hess-Bright deep groove type, S K F self-aligning radial and thrust bearings and ball bearing pillow-blocks and shafting hangers.

Through the medium of its engineering organization, backed up by a well equipped laboratory, the new company will be able to place at the service of bearing users the knowledge gained in many years' study of anti-friction bearings of all kinds. On request, manufacturers' problems will be analyzed in detail and that type of bearing recommended which (independent of sales considerations) is best suited to the conditions met. In addition the laboratory staff will carry on research studies affecting anti-friction bearing design and application.

The new company—S K F Industries, Inc.—will be under the direction of B. G. Prytz, president; W. L. Batt, vice-president; principal office will be at 165 Broadway, New York, with branches at Boston, Philadelphia, Atlanta, Buffalo, Cleveland, Detroit, Cincinnati, Chicago, and San Francisco.

New York-Chicago Non-Stop Flight

The first non-stop air flight from Chicago to New York was made on April 19, by Capt. E. F. White, Air Service, who covered the air distance of about 725 miles in six hours and fifty minutes.

The flier, accompanied by H. M. Schaler, a civilian mechanician, left Ashburton Field, his starting point, at 9.50 a. m., Central time, and arrived at Hazelhurst Field, Mineola, L. I., at 5.40 p. m., Eastern time.

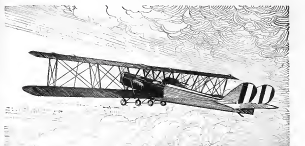
The machine used was a De Haviland-4, with a 12-cyl. Liberty engine. It carried its gasoline capacity of 194 gal.

Hun Bombers Carry French Food

German bombing airplanes of the Friedrichshafen type, which were surrendered to the Allies under a clause of the armistice, will be used by the French Department of Civilian Aviation in transporting foodstuffs between Paris and Bordeaux. The airplanes will be equipped to carry three tons of parcels and bundles each.

Twenty-Passenger Airplane Building

A twenty-passenger airplane for service between New York and Chicago is being built by the recently organized Lawson Air Line Transportation Co. at its factory in Milwaukee. It is expected that the machine will be ready for trials by July 1, next.



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Thus, within the next year Mr. Klemin will discuss with complete authoritative data what he calls "that technical branch of aeronautics which involves the systematic testing of an airplane or its component parts for the purpose of improvement or innovation, and thus from the main viewpoints of structural strength, performance, stability, and controllability. The work, though it may be concerned with the very latest developments, is entirely distinct from the purely aerodynamic research of the physicist. It is engineers' work and should be carried on by engineers even though the physicist may give the scientific foundation or help in devising accurate instruments. A very complete technique has grown up and it is the principles and utilization of this technique that it is proposed to deal with" in the article on *Experimental Aeronautical Engineering*.

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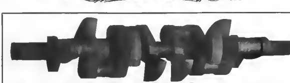

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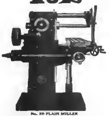

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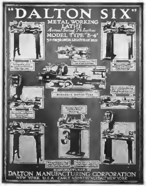

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24 1912, of AVIATION AND AERONAUTICAL ENGINEERING published semi monthly at New York, N Y, for April 1, 1919

State of New York }
County of New York } ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared Herbert M. Williams, who having been duly sworn according to law, deposes and says that he is the Business Manager of Aviation and Aeronautical Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443 Postal Laws and Regulations, to wit

1 That the names and addresses of the publisher editor, managing editor, and business managers are

Publisher Gardner-Moffat Company Inc 22 East 17th Street New York; Editor Lester D Gardner, 22 East 17th Street, New York, Business Managers Herbert M Williams George Newbold, 22 East 17th Street, New York

2 That the owners are (Give names and addresses of individual owners or if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock)

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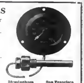

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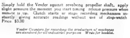

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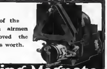

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